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(54) **REGISTERING OF A SCENE DISINTEGRATING INTO CLUSTERS WITH VISUALIZED CLUSTERS**

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CPC *G06T 7/0075* (2013.01); *G01C 15/002* (2013.01); *G01S 7/4817* (2013.01); *G01S 17/89* (2013.01); *G06T 7/0032* (2013.01)

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(57) **ABSTRACT**

A method for optically scanning and measuring a scene by a three-dimensional (3D) measurement device in which multiple scans are generated to then be registered in a joint coordinate system of the scene. At first at least one cluster is generated from at least one scan, further scans are registered for test purposes in the coordinate system of the cluster, if specified quality criteria are fulfilled and the generated clusters are then joined, for which purpose clusters are selected, registered for test purposes and registering is confirmed if appropriate, wherein the clusters to be joined are visualized with an optional possibility for the user to intervene, for supporting the selection of clusters.

11 Claims, 5 Drawing Sheets
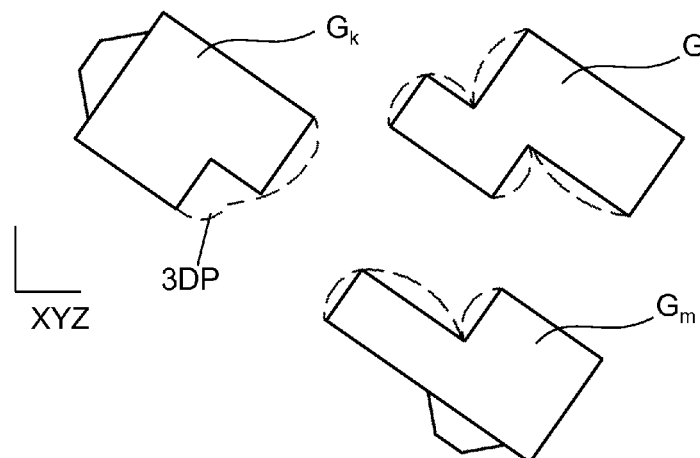
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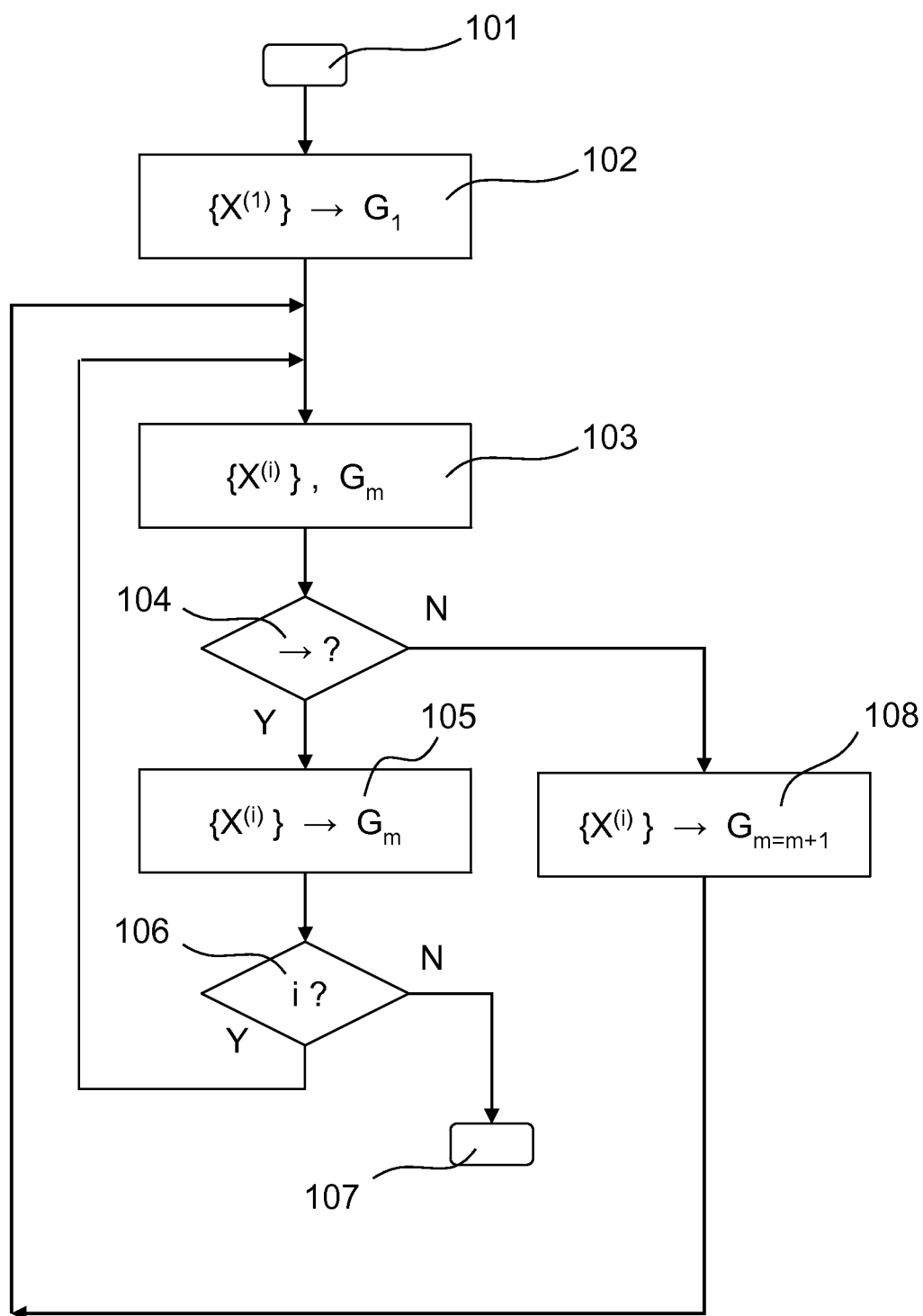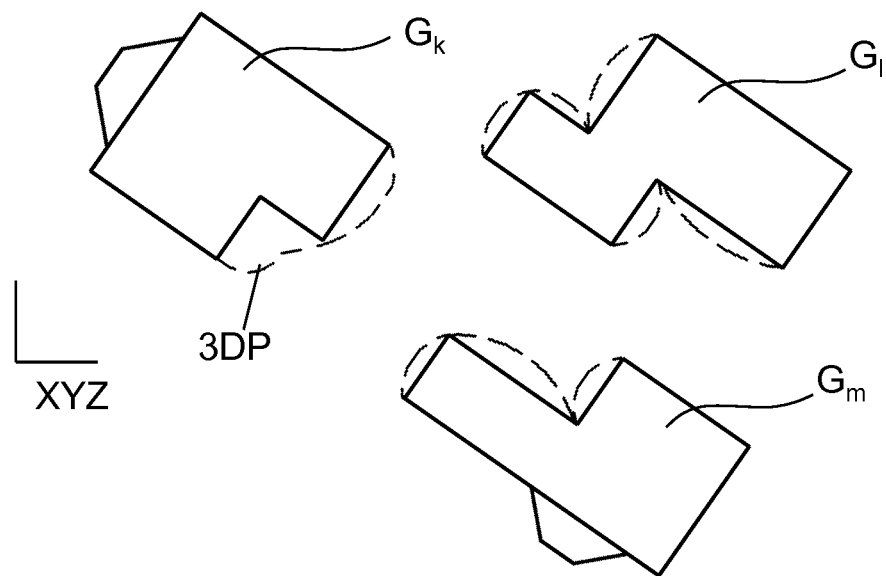
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101

$$\{X^{(1)}\} \rightarrow G_1$$

102

$$\{X^{(i)}\}, \; G_m$$

103

104

$$\rightarrow ?$$

N

Y

$$\{X^{(i)}\} \rightarrow G_m$$

105

$$\{X^{(i)}\} \rightarrow G_{m=m+1}$$

108

106

$$i ?$$

N

Y

107

Fig. 1

G_k

G_l

3DP

XYZ

G_m

Fig. 2

$T_2^{(i)}$

$T_1^{(i)}$

$T_3^{(i)}$

$T_4^{(i)}$

$T_2^{(j)}=T_2^{(i)}$

$T_1^{(j)}=T_1^{(i)}$

$T_3^{(j)}=T_3^{(i)}$

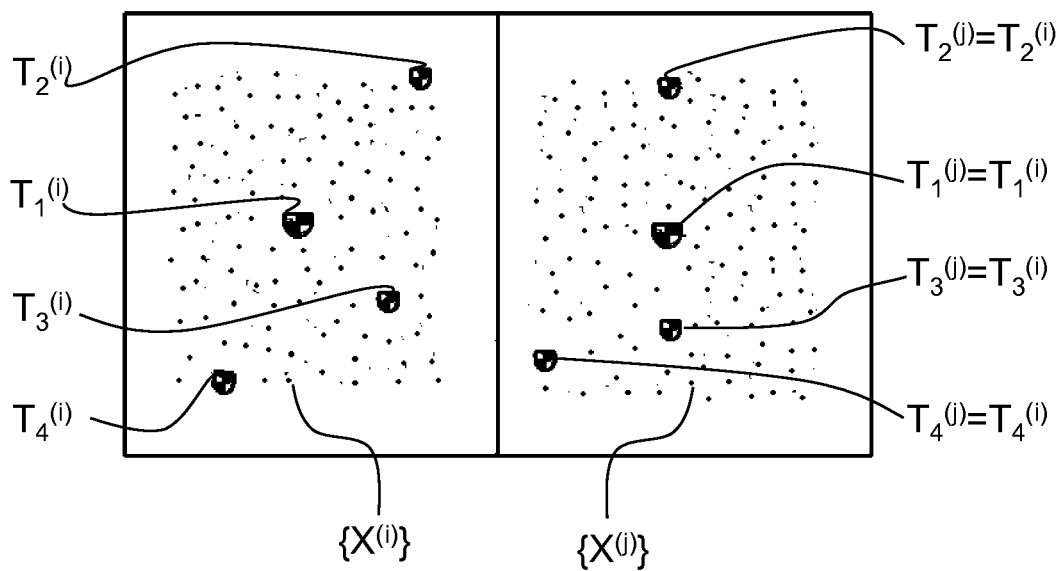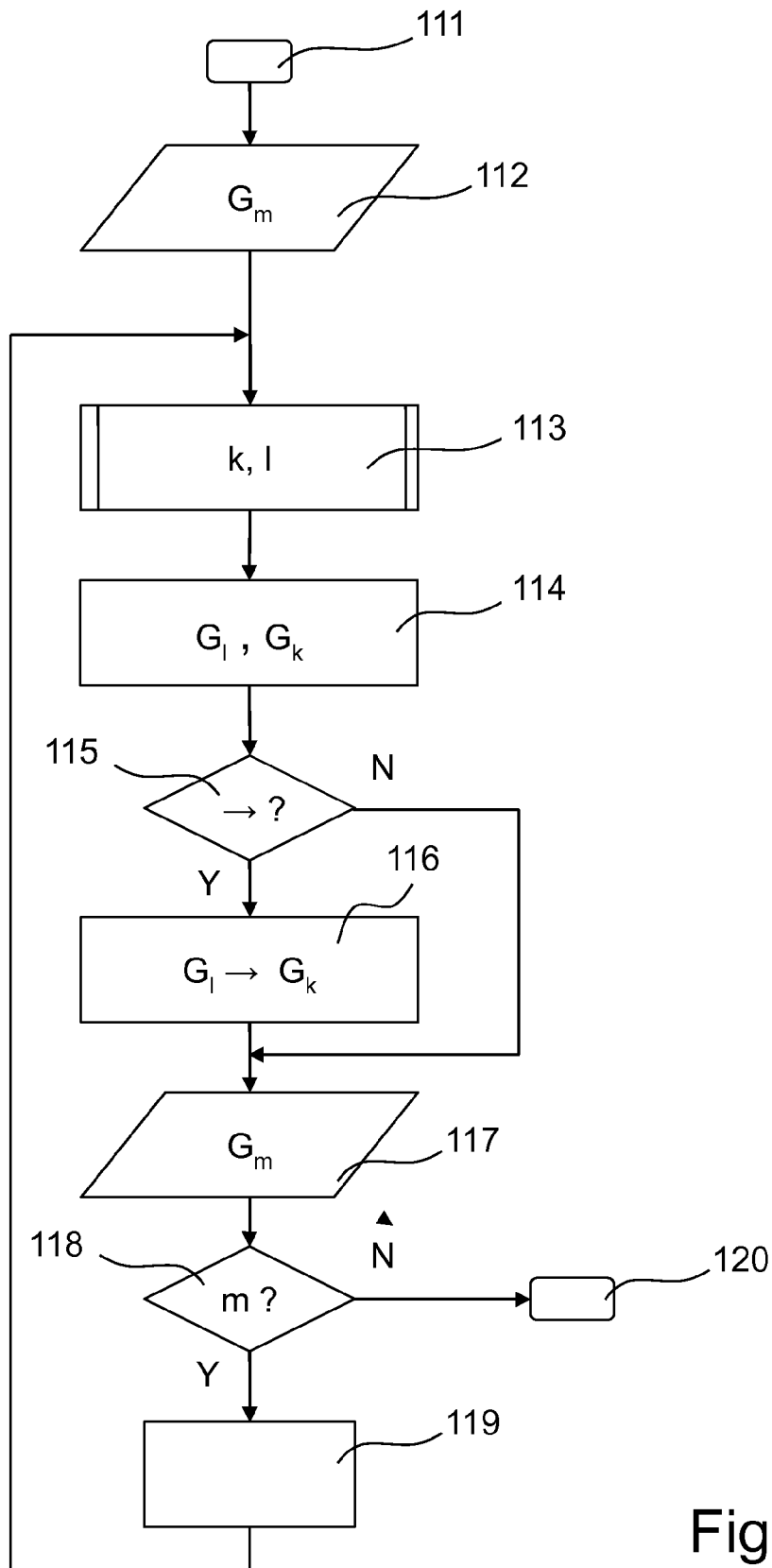$T_4^{(j)}=T_4^{(i)}$
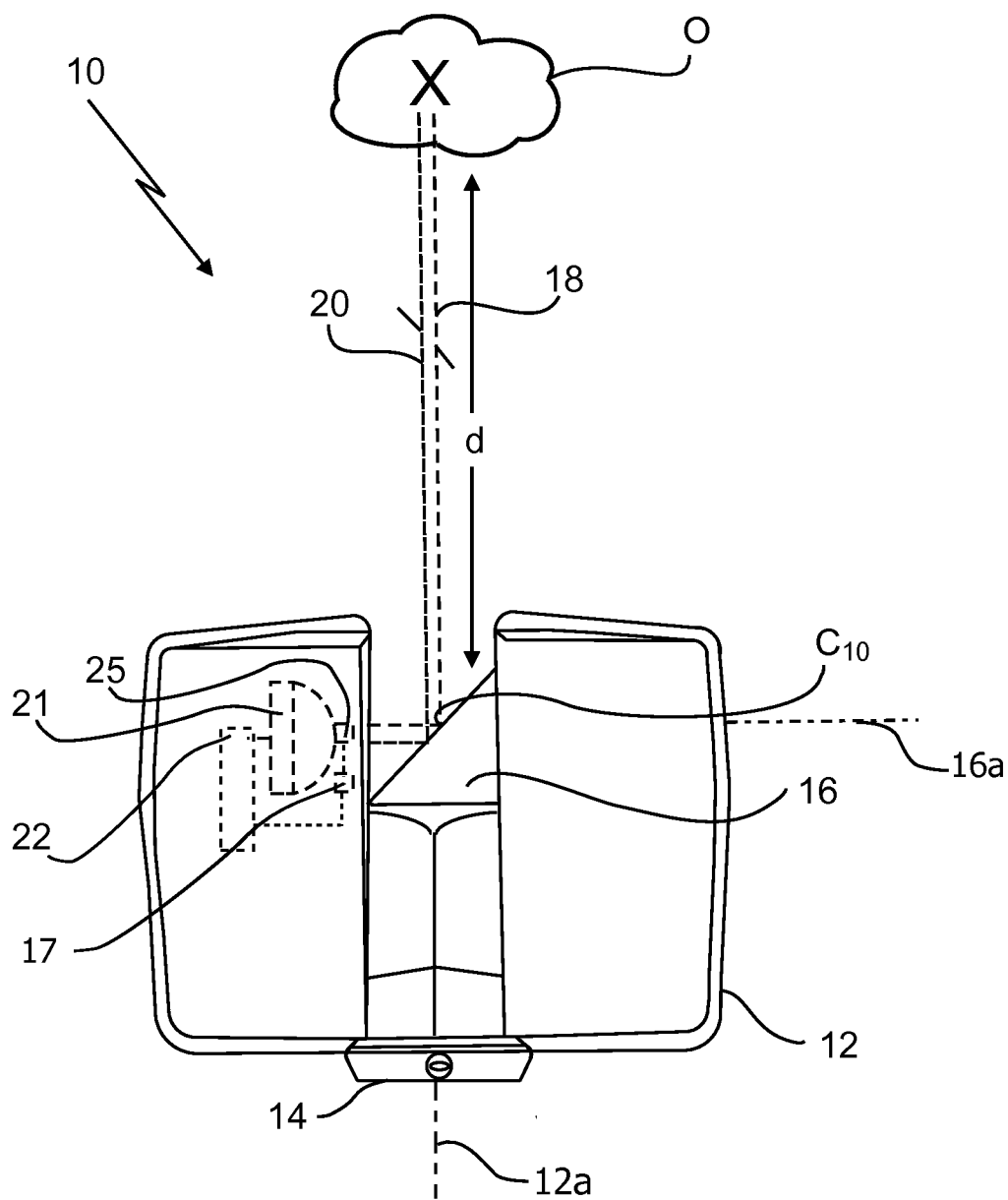
$\{X^{(i)}\}$

$\{X^{(j)}\}$
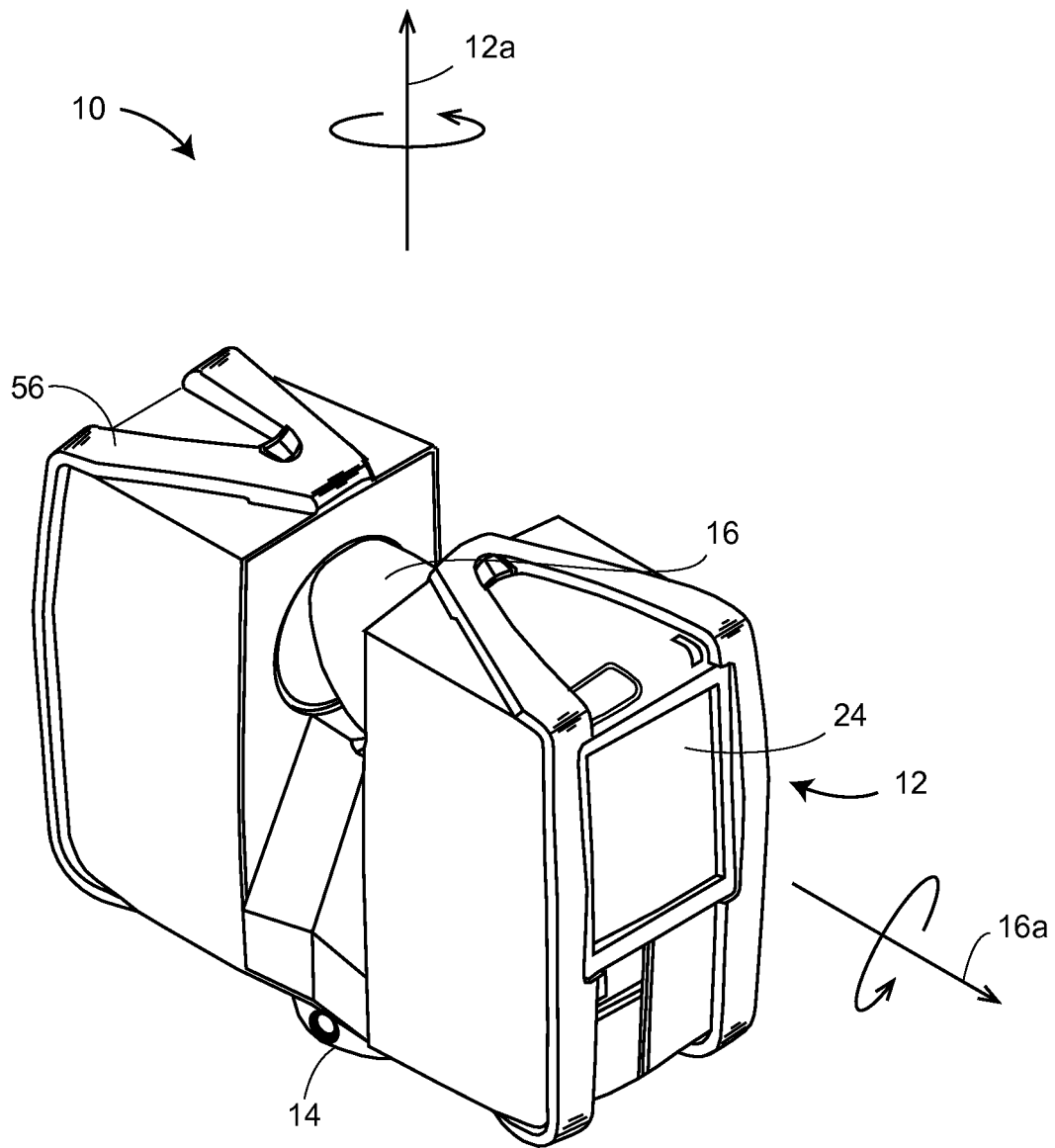
Fig. 3

Fig. 4

Fig. 5

Fig. 6

REGISTERING OF A SCENE DISINTEGRATING INTO CLUSTERS WITH VISUALIZED CLUSTERS

CROSS REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of German Patent Application No. DE102014104712.5, filed on Apr. 2, 2014, the contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The invention relates to a method for optically scanning and measuring a scene using a laser scanner.

BACKGROUND OF THE INVENTION

German Published Patent Application No. DE102009015922A1 describes a method for optically scanning and measuring a scene using a laser scanner, in which a scene is registered with multiple scans. For this purpose, the laser scanner is taken to a new location after a scan to generate an additional scan. The generated scans with their measuring points are registered in a joint coordinate system, wherein the entity of measuring points forms a three-dimensional (3D) point cloud.

Through use of known methods for registering multiple scans of a scene, the registering process, which may be based on the pairwise examination of two scans, should theoretically be unambiguous and may take place completely automatically. In practice, however, for reasons of performance, not all scans are typically examined pairwise, but usually only within a neighborhood that results, for example, from the history of registering of the scene. This is why interruptions in the registering process may occur.

Embodiments of the present invention are based on improving a method of the type mentioned hereinabove.

SUMMARY OF THE INVENTION

According to embodiments of the present invention, at first at least one cluster is generated from at least one scan, to which further scans are added, as long as specified quality criteria are fulfilled. Otherwise, a new cluster is generated. When auto clustering has taken place, the clusters are joined. For this purpose, the clusters and/or scans must be selected pairwise and be registered for test purposes.

The selection of the clusters and/or scans for joining the clusters can take place in different ways. As long as the scans in their entity get sufficient information, strategies are possible which permit an automatic joining of the clusters with a good performance, particularly if strategies are pursued already when clustering. Cumulatively (i.e., for additionally supporting and accelerating) or alternatively (in particular if the information gathered from the scans is in its entity not sufficient or if it is ambiguous), interventions by the user can take place. In case of a post registration, these interventions can be, for example, supports in selecting the pairs, and in case of an onsite registration then additional scans. In all cases, confirmations by the user can be requested after the proposed joining to a cluster.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained in more detail below on the basis of exemplary embodiments illustrated in the drawings, in which:

FIG. 1 is a schematic flow diagram of a method of automatic clustering;

FIG. 2 is a schematic representation of clusters;

FIG. 3 is a schematic representation of two scans as a split view;

FIG. 4 is a schematic flow diagram of a method of the joining of the clusters;

FIG. 5 is a schematic, partially cut representation of a laser scanner in operation, and

FIG. 6 is a perspective view of the laser scanner of FIG. 5.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 5 and 6, embodiments of the present invention relate to a 3D coordinate measurement device which steers a beam of light to an object O, which may either be a cooperative target such as a retroreflector or a non-cooperative target such as a diffusely scattering surface of the object O. A distance meter in the device measures a distance to the object O, and angular encoders measure the angles of rotation of two axles in the device. The measured distance and the two angles enable a processor in the device to determine the 3D coordinates of the object O. Embodiments of the present invention disclose a laser scanner 10 as the 3D coordinate measurement device, but various other embodiments utilizing a laser tracker or total station should be clear to one of ordinary skill in the art. The 3D measurement device may also be a portable freestyle device with a projector generating a light pattern (e.g., infrared light pattern) onto the object O and one or more cameras capturing the light pattern on the object O.

Laser scanners are typically used for scanning closed or open spaces such as interior areas of buildings, industrial installations and tunnels. Laser scanners are used for many purposes, including, for example, building information modeling (BIM), industrial analysis, accident reconstruction applications, archaeological studies, and forensics investigations. A laser scanner can be used to optically scan and measure objects in a volume around the laser scanner through the acquisition of data points representing objects within the volume. Such data points are obtained by transmitting a beam of light onto the objects and collecting the reflected or scattered light to determine the distance, two-angles (i.e., an azimuth angle and a zenith angle), and optionally a gray-scale value. This raw scan data is collected, stored and sent to a processor or processors to generate a 3D image representing the scanned area or object. To generate the image, at least three values are collected for each data point. These three values may include the distance and two angles, or may be transformed values, such as x, y, z coordinates.

In FIGS. 5 and 6, a laser scanner 10 is shown for optically scanning and measuring the environment surrounding the laser scanner 10. The laser scanner 10 comprises a measuring head 12 and a base 14. The measuring head 12 is mounted on the base 14 such that the measuring head 12 can rotate with respect to the base 14 about a first axis 12a, driven by a first rotary drive. The rotation about the first axis 12a may be about the center of the base 14. The measuring head 12 comprises a mirror 16, which can rotate about a second axis 16a, driven by a second rotary drive. Referring to a normal upright position of the laser 10, the first axis 12a may be called the vertical axis or azimuth axis, while the second axis 16a may be called the horizontal axis or zenith axis. The laser scanner 10 may comprise a gimbal point or center C_{10} that is the intersection point of the first axis 12a and the second axis 16a.

The measuring head 12 is further provided with an electromagnetic radiation emitter, such as light emitter 17, for

example, that emits an emission light beam **18**. In an embodiment, the emission light beam **18** is a coherent light such as a laser beam. The laser beam may have a wavelength range of approximately 300 to 1600 nanometers, for example 790 nanometers, 905 nanometers, 1550 nanometers, or less than 400 nanometers. It should be appreciated that other electromagnetic radiation beams having greater or smaller wavelengths may also be used. The emission light beam **18** may be amplitude or intensity modulated, for example, with a sinusoidal waveform or with a rectangular waveform. Alternatively, the emission light beam **18** may be otherwise modulated, for example, with a chirp signal, or coherent receiver methods may be used. In the present embodiment, the emission light beam **18** is a continuous wave laser beam. However, it may also be a pulsed laser. The emission light beam **18** is emitted by the light emitter **17** onto the mirror **16**, where it is deflected to the environment of the laser scanner **10**.

A reflected light beam, hereinafter called a reception light beam **20**, is reflected from the environment by an object O. The reflected or scattered light is intercepted by the rotary mirror **16** and directed onto a light receiver **21** with reception optics. The directions of the emission light beam **18** and the reception light beam **20** result from the angular positions of the measuring head **12** and the mirror **16** about the axes **12**a and **16**a, respectively. These angular positions in turn depend on the corresponding rotary drives. The angle of rotation about the first axis **12**a is measured by a first angular encoder. The angle of rotation about the second axis **16**a is measured by a second angular encoder.

A control and evaluation unit **22** has a data connection with the light emitter **17** and the light receiver **21** inside the measuring head **12**, whereby parts of the control and evaluation unit **22** can be arranged also outside the measuring head **12**, for example as a computer connected to the base **14**. The control and evaluation unit **22** is configured to determine, for a multitude of measuring points X, a corresponding number of distances d between the laser scanner **10** and the measuring points X on object O. The distance to a particular measuring point X is determined based at least in part on the speed of light in air through which electromagnetic radiation propagates from the device **10** to the measuring point X. In an embodiment, the phase shift in the modulated light beam **18**, **20**, sent to the measuring point X and received from it, is determined and evaluated to obtain a measured distance d.

The speed of light in air depends on the properties of the air such as the air temperature, barometric pressure, relative humidity, and concentration of carbon dioxide. Such air properties influence the index of refraction of the air. The speed of light in air is equal to the speed of light in vacuum divided by the index of refraction. A laser scanner of the type discussed herein is based on the time-of-flight of the light in the air (the round-trip time for the light to travel from the device to the object and back to the device). A method of measuring distance based on the time-of-flight of light (or the time-of-flight of any type of electromagnetic radiation) depends on the speed of light in air and is therefore easily distinguished from methods of measuring distance based on triangulation. Triangulation-based methods involve projecting light from a light source along a particular direction and then intercepting the light on a camera pixel along a particular direction. By knowing the distance between the camera and the projector and by matching a projected angle with a received angle, the method of triangulation enables the distance to the object to be determined based on known length and two known angles of a triangle. The method of triangulation, therefore, does not directly depend on the speed of light in air.

The measuring head **12** may include a display device **24** integrated into the laser scanner **10**. The display device **24** includes a user interface, which may be a graphical touch screen, as shown in FIG. **6**. For example, the display device **24** may have a user interface that allows the operator to provide measurement instructions to the laser scanner **10**, in particular to set the parameters or initiate the operation of the laser scanner **10**, and the display device **24** may also display measurement results.

In an embodiment, the scanning of the environment of the laser scanner **10** takes place by rotating the mirror **16** relatively quickly about the second axis **16**a while rotating the measuring head **12** relatively slowly about the first axis **12**a, thereby moving the assembly in a spiral pattern. In an exemplary embodiment, the rotary mirror **16** rotates at a maximum speed of 5820 revolutions per minute. A scan is defined to be the entity of measuring points X in such a measuring. For such a scan, the center C_{10} defines the origin of the local stationary reference system. The base **14** rests in this local stationary reference system.

In addition to measuring a distance d from the center C_{10} to a measuring point X on the object O, the laser scanner **10** may also collect gray-scale values related to the received optical power. The gray-scale value may be determined, for example, by integration of the bandpass-filtered and amplified signal in the light receiver **21** over a measuring period attributed to the measuring point X. Optionally, color images can be generated by a color camera **25**. Through use of these color images, colors (R, G, B) can be assigned to the measuring points X as additional values.

To scan a scene from different directions or a large space, multiple scans are captured from different locations (corresponding to an amount of different centers) and then registered in a joint coordinate system XYZ of the scene. The laser scanner **10** must change its location for this purpose, thus moving each time the center C_{10} of the laser scanner **10** within the joint coordinate system XYZ to a new center from the amount.

For registering the scans, point-based methods or methods using targets can be used. In an exemplary embodiment, registering is performed through use of targets. The targets are localized and identified in overlapping areas of the scans. Both, "natural" targets, i.e., certain formations of the object O, and "artificial" targets, i.e., targets which have been applied especially for the scanning process to the object O or to the environment, for example checker-board patterns, are appropriate as targets. The geometry in which a target is embedded and which is defined by the adjacent targets, is determined for each target, for example as described in the aforementioned German Published Patent Application No. DE102009015922A1. The embedding geometries can then be compared with each other to first automatically find corresponding pairs of targets and then find the best possible assignment of the two scans. When all scans are registered in the joint coordinate system XYZ, the entity of all measuring points X of all scans forms a three-dimensional point cloud **3DP**.

It is usually possible to register all scans through use of the targets, even without having additional information on the relative positions of the centers of the scans. To improve performance, the time stamp of the scans can be used to find and register adjacent scans faster. The result of registering can be shown on the display unit **24**. A confirmation by the user is optional.

It is, however, also possible that problems occur during registering, for example not enough targets in overlapping areas of the scans, ambiguous, embedding geometries or a

difficult topology. It is also possible that problems are present which are not recognized immediately, but only by the user. Therefore, auto clusters can be generated which comprise unambiguously matching scans. For defining such unambiguous matching, specified quality criteria can be defined which must be fulfilled. Such a quality criterion can be, for example, a threshold value for the remaining inverse squares of the targets, after the embedding geometries have been assigned, wherein the quality criterion shall increase with increasing concordance.

In FIG. **1**, a schematic representation of the procedure during "auto-clustering" shows how it can be automatically carried out, for example, through use of a suitable filtering device. After an initial step **101**, a first cluster G_l is defined in a processing step **102**, and the first scan $\{X^{(1)}\}$—initially as the only scan—is assigned to it (shown by an arrow). This first scan $\{X^{(1)}\}$ also defines the coordinate system of the first cluster G_l. For a following loop which processes a cluster G_m during every cycle, therefore, during the first cycle, m=1. The further scans $\{X^{(i)}\}$ start with i=2.

The loop then starts, the loop containing a processing step **103** in which a further scan $\{X^{(i)}\}$ is registered for test purposes in the coordinate system of the cluster G_m which is processed at present. The cluster G_m can contain a relatively large quantity of targets. There are two possibilities. Either, for reasons of performance, a pair is formed, for example, from the last successfully registered scan (or another scan) of the cluster G_m and the further scan $\{X^{(i)}\}$. Or, for reasons of improved success in registering, the pair is formed from the cluster G_m (complete cluster G_m or peripheral portion composed of several scans) and the further scan $\{X^{(i)}\}$. The expression "peripheral portion" should paraphrase that the cluster G_m is composed of many scans overlapping with their respective neighbors, and it is rather probable that a further scan $\{X^{(i)}\}$ is not overlapping with registered scans in the center of the cluster G_m but with (several) registered scans in the periphery of the cluster G_m, wherein the common targets in the overlapping parts of the scans are used for registering the scans. In particular, the number of common targets in the peripheral portion of the cluster G_m, formed of several scans, is larger than the number of targets of a single scan of the cluster G_m, thus increasing the probability for a success in registering the further scans $\{X^{(i)}\}$. The pair is registered for test purposes.

A decision process **104** checks whether registering has been successful, i.e., whether the quality criteria for registering are fulfilled. If this is the case (Y), registering is confirmed (by the procedure) in a processing step **105**, otherwise (N), registering for test purposes is rejected.

A subsequent decision step **106** checks whether further scans $\{X^{(i)}\}$ are available, which have not yet been registered for test purposes in this loop ("free scans"). Such a check usually will take place by an incrementing loop counter (e.g., number "I" of the scan) and of appropriate flags. If such free scans $\{X^{(i)}\}$ are still available (Y), the loop jumps back to processing step **103** with registering for test purposes. The decision step **106** could take place also at the beginning of the loop. If no free scans $\{X^{(i)}\}$ are available any longer, auto-clustering ends with a final step **107**.

If registering for test purposes is rejected after the decision step **104**, a new cluster G_m (with m=m+1) is defined in a processing step **108**, and the last scan $\{X^{(i)}\}$ registered for test purposes, is assigned to this new cluster G_m. This last-named scan $\{X^{(i)}\}$ defines the coordinate system of the new cluster G_m. The procedure is then continued with processing step **103** of the registering for test purposes.

In a modified embodiment, a new cluster is not immediately started in case of an unsuccessful registering for test purposes, but a specified number of the next free scans $\{X^{(i)}\}$ is tested instead for assigning to the present cluster G_m. With a view to performance, it is appropriate to limit the number of these scans still to be tested, by defining a limit, for example by the time stamp or the continuous number of the scan, i.e., a limit with respect to space and/or time, so that it is only tried to register scans which are adjacent with respect to time (and consequently usually also with respect to space) for test purposes. This reduces time consumption or the complexity of registering.

In an alternative to the described serial procedure, the scans $\{X^{(i)}\}$ can be tested pairwise, in a more parallel method (corresponding to the crystal growth), for registering for test purposes. From each matching pair, a cluster G_m is formed as a nucleation site. From the clusters G_m or from single scans from the clusters G_m and the free scans $\{X^{(i)}\}$, new pairs arise, which again are checked for being registered for test purposes, until, in the end, no further registering is successful.

In the case of a building, the clusters G_m frequently comprise adjacent scans $\{X^{(i)}\}$ of the same room, the same floor, the same building or from its interior and exterior.

The problem remains to join the clusters G_m, for example on an appropriate registering device. It must thereby be taken into account (as in processing step **103**) that the clusters G_m contain a relatively large amount of targets. For reasons of performance, when forming the pairs, single scans $\{X^{(i)}\}$ may be selected from the clusters G_m. However, for increasing the success of registering for test purposes, and in particular if pairs of single scans $\{X^{(i)}\}$ were used in step **103**, it is better to use whole clusters G_m or peripheral portions thereof. Either a single scan $\{X^{(i)}\}$ is selected from a first cluster G_m, and the second cluster G_l is used as a whole or in a peripheral portion. Or the pairs are formed by two clusters G_m, G_l and/or peripheral portions thereof. Such a scan $\{X^{(i)}\}$ selected from a first cluster G_k, is then registered (for test purposes), for example, in the coordinate system of a second cluster G_l. Joining of the clusters G_m can be visualized, for example to show the progress or to get an optional confirmation of the user or to request an optional support by the user.

A possible first visualization ("correspondence view") is the compressed representation of all clusters G_m, side by side, for example on the display unit **24**. The expression "side by side" means a spatial adjacent arrangement of the clusters G_m on the display without penetration or overlap of the clusters G_m. The visualization tries to use structures and features of the clusters G_m which help the user to recognize the clusters G_m. In the case of a building, it is appropriate to select a top view of the clusters G_m, corresponding to a floor plan of the building. In FIG. **2** this is shown in an exemplary manner with three clusters G_k, G_l and G_m, wherein the continuous lines are supposed to represent recognized walls and broken lines the approximate extension of the three-dimensional point cloud **3DP**. Updated visualizations show the progress when joining the clusters. That is, once two clusters G_m have been joined, they are visualized in this joined state on the display. Every pair of joined clusters G_m is a partial success. It should be noted that in special cases, e.g., if a cluster G_m extends on two floors of the building, it may helpful to form sub-clusters of said G_m, e.g., one sub-cluster in each floor. Each of these sub-clusters may then be displayed side by side with the other clusters G_m of the same floor. Selecting one of the floors, the user may have a top view on all clusters G_m of the selected floor.

A possible second visualization ("split view") is the representation of the pair of clusters G_k, G_l (which are processed at

the moment) or of selected scans $\{X^{(i)}\}$, $\{X^{(j)}\}$ from the clusters G_k, G_l, in a split (screen) view, as shown in FIG. **3**. This representation of the two scans $\{X^{(i)}\}$, $\{X^{(j)}\}$ with their targets $T^{(i)}_1$, $T^{(i)}_2$, $T^{(i)}_3$, $T^{(i)}_4$ and $T^{(i)}_1$, $T^{(i)}_2$, $T^{(i)}_3$, $T^{(i)}_4$ is schematic, since the assumed relative rotation would be unproblematic in reality. Both visualizations can also be combined in such a way that a change between them is possible.

Joining of the clusters G_m with optional visualization is shown as a flow chart in FIG. **4**. After an initial step **111** the above-described visualization takes place in an optional output step **112**. In a subprogram **113** which is invoked (and described later), two clusters and each one scan from each of the two clusters are selected, which together build a pair to be registered for test purposes. More precisely, a scan $\{X^{(i)}\}$ is selected from a first cluster G_k, such scan being supposed to be registered for test purposes in the coordinate system of a second cluster G_l, for which, in turn, a scan $\{X^{(j)}\}$ is selected representatively from this second cluster G_l, and the two scans $\{X^{(i)}\}$, $\{X^{(j)}\}$ form the pair.

In a processing step **114** it is tried to register the pair for test purposes—as in processing step **103**—and to thus join the clusters. In a decision step **115** it is checked whether such joining has been successful. If this is the case (Y), registering is confirmed in a processing step **116** (corresponding to processing step **105**), and optionally a new output step **117**, corresponding to output step **112** takes place. Otherwise (N) the two clusters remain separate. In a further decision step **118** (which can be arranged also at another point of the loop) it is checked, whether there are still clusters G_m available, which have not yet been joined, i.e. which are still "free." If this is the case (Y), the loop continues, invoking the subprogram **113**, and adding a processing step **119**. Otherwise (N) all clusters G_m are joined, so that it is possible to finish with a final step **120**. The optional, added processing step **118**, which can be carried out also at the beginning of the loop, changes parameters, if all free clusters have already been tested unsuccessfully with a view to joining. In particular, the quality criteria for registering the scans for test purposes can be reduced.

The subprogram **113** with the selection and formation of the pairs can be implemented in different, modified ways.

A first possibility is to strategically select the clusters G_k, G_l and/or the scans $\{X^{(i)}\}$, $\{X^{(j)}\}$ for forming the pairs. If two clusters G_k, G_l, which are consecutive regarding their time stamp are selected, then multiple scans $\{X^{(i)}\}$ from a first cluster G_k can be selected consecutively (e.g., each time the subprogram **113** is invoked) to form pairs with the first scan $\{X^{(j)}\}$ of the second cluster G_l which is later—with a view to the time stamp. If appropriate, only the last scan $\{X^{(i)}\}$ is selected from the first cluster G_k. Again, the first cluster G_k and the second cluster G_l may be selected as a whole or peripheral regions of the two clusters G_k, G_l may be selected. Or the pair is formed by the whole (or peripheral portion of the) first cluster G_k on one hand and the first scan $\{X^{(j)}\}$ of the second cluster G_l on the other hand. It then proceeds on the assumption that the first cluster G_k will come to a dead end and that the second cluster G_l branches at an earlier point which, due to the defined limit with respect to space and/or time in decision step **106**, has not yet been checked. Within the strategy, the limit is repealed. Further strategies are possible. In case of a building, a further strategy may be to distinguish clusters G_k, G_l by floors. The floors may be detected by an altimeter, e.g., being a built-in sensor of the 3D measurement device.

Since some of the pairs have already been tested unsuccessfully once (which is appropriate to be noted), the processing step **118** with the modified parameters can be helpful.

Such implementation of the subprogram **113** (with strategic selection) provides a completely automatic method for selecting the clusters G_k, G_l and the scans $\{X^{(i)}\}$, $\{X^{(j)}\}$. Modifying the parameters may comprise a reduction of the quality criteria. As subprogram **113** is inside a loop, the reduction will be iterative. With reduced quality criteria, a final confirmation by the user becomes appropriate, however.

A second possibility is to assume a support by the user in subprogram **113**, i.e., a semi-automatic method for joining the clusters G_m.

In the case of the first visualization with the clusters side by side (FIG. **2**), the user can shift the clusters relative to each other by an appropriate input unit, for example a mouse. The user shifts, for example cluster G_l to cluster G_k, so that the point clouds overlap. With the information gained from the input and output units, the concerned cluster G_k and cluster G_l can be set in a spatial relationship to each other, and the appropriate scans can be selected therefrom. Since the corresponding targets are in immediate vicinity to each other, registering for test purposes in processing step **114** will then soon be successful.

In the case of the second visualization in a split view, FIG. **3** shows the two scans on the left and on the right. The targets $T^{(i)}_1$, $T^{(i)}_2$, $T^{(i)}_3$, $T^{(i)}_4$ of the scan represented on the left $\{X^{(i)}\}$ are supposed to correspond with the targets $T^{(i)}_1$, $T^{(i)}_2$, $T^{(i)}_3$, $T^{(i)}_4$ of the scan $\{X^{(j)}\}$ represented on the right. The user can provide for this correspondence by an appropriate input unit, for example a mouse or a touchscreen. At first it is tried to carry out registering for test purposes with two pairs of such corresponding targets, for example $T^{(i)}_1$ and $T^{(i)}_1$ as well as $T^{(i)}_2$ and $T^{(i)}_2$ in processing step **114**. With each further invoking of subprogram **113**, a further pair of corresponding targets would be called.

A third possibility exists in the case of an onsite registration. For this purpose, the scans $\{X^{(i)}\}$ are registered, i.e., joined to a cluster, already while the scene is still being registered (i.e. scanned and measured optically), i.e., as long as the user with laser scanner **10** is still on site. Registering may take place between two scans when the color camera **25** is used. Optionally, the laser scanner **10** allows for the next (regular) scan $\{X^{(i)}\}$ only when a registering of the scans made until now has been successful.

If the previous cluster shall be terminated and a new cluster is started, i.e., if registering for test purpose has been unsuccessful, subprogram **113** can request the user to generate at least one additional (extraordinary) scan $\{X^{(j)}\}$, usually in the area scanned last, from which the cluster which has just been terminated and the cluster which has been started (i.e., the unsuccessfully joined clusters) come, and which can be visualized to the user in a contemporary way. The later the call for the additional scan $\{X^{(j)}\}$ takes place, the more difficult is it for the user to find the correct area with the unsuccessfully joined clusters.

The pairs are formed from the additional scan $\{X^{(j)}\}$ and from selected, available scans $\{X^{(i)}\}$ of the cluster which has just been terminated. Selection can again take place strategically (and automatically), as in the first possibility of implementing subprogram **113**. When the terminated cluster has been successfully complemented with the additional scan, it is tried to join the terminated cluster and the cluster which has just been started. If appropriate, a further call for an additional scan takes place.

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, sub-

stitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

What is claimed is:

1. A method for optically scanning and measuring a scene by a three-dimensional (3D) measurement device in which multiple scans are generated by the device, and the multiple scans are then registered in a joint coordinate system of the scene, comprising:

    generating at least one cluster from at least one scan of the multiple of scans;

    registering additional scans from the multiple of scans for test purposes in a coordinate system of the generated at least one cluster;

    confirming the registering of the additional scans if specified quality criteria are fulfilled; and

    joining clusters generated from the additional scans by selecting at least two clusters and registering the at least two clusters for test purposes and confirming the registering, wherein the clusters to be joined are visualized for supporting user selection of the at least two clusters.

2. The method of claim 1, wherein the clusters to be joined are visualized side by side in a compressed representation of all clusters.

3. The method of claim 1, wherein progress of joining the clusters is shown.

4. The method of claim 1, wherein the selected at least two clusters are shifted relative to each other.

5. The method of claim 4, wherein the selected at least two clusters are shifted relative to each other such that point clouds associated with each of the at least two clusters overlap.

6. The method of claim 5, wherein the selected at least two clusters which have been shifted relative to each other are set in spatial relationship to each other with information gained from input and output units, and that scans are selected from the selected at least two clusters to form pairs of selected scans.

7. The method of claim 6, wherein the pairs of selected scans are registered for test purposes and registering is confirmed is specified quality criteria are fulfilled.

8. The method of claim 1, wherein automatic registering for test purposes use targets in overlapping areas of the scans or point-based methods.

9. A 3D measurement device for carrying out the method of claim 1, comprising a control and evaluation unit which determines, for a plurality of measuring points of every one of the scans at least a distance from the a center of the 3D measurement device to the object and registers the generated scans in a joint coordinate system of the scene.

10. The 3D measurement device of claim 9, configured as a laser scanner comprising a base, a measuring head which is rotatable with regard to the base, a light emitter which emits an emission light beam, a light receiver which receives a reception light beam which is reflected by an object in the environment of the laser scanner or scattered otherwise, wherein the center of the laser scanner rests while a scan is made and is movable between the scans.

11. The 3D measurement device of claim 9, further comprising a display unit for visualizing the clusters to be joined.

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